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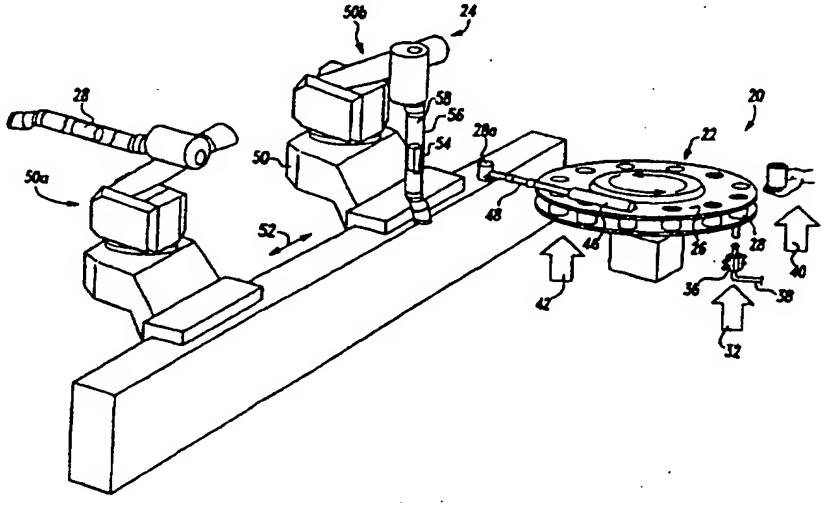

(57) Abstract

A paint system (20) comprises a paint supply system (22) supplying paint to a paint spray system (24). A transport assembly is provided, such as a rotatable magazine (26) for a multitude of interchangeable containers (28) for a coating machine which containers are filled at a location separated from the coating machine and are removed from the magazine at a discharge point and supplied to the coating machine and, after use, are again returned to the magazine. The coating machine includes a spray device mounted at an outer end of a moveable spray arm (58). The arm includes a housing into which filled containers are inserted and a piston rod which engages a piston in the container to force paint out of the spray device. A meter measuring the relative position of the piston rod determines the volume rate of paint flow based upon the rate of change of the position of the piston rod.

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PAINT SYSTEM WITH COLOR CHANGE CANISTERS

BACKGROUND OF THE INVENTION

The invention relates to a paint system for supplying paint to a coating device for the production line coating of workpieces, particularly vehicle bodies.

A known paint system such as disclosed in EP-PS 0 274 322, includes an enameling robot which carries the spraying device. Interchangeable containers are filled at dispensing stations that are annexed to paint supply lines and are located in the spray booth in the movement range of the robot, from where they are picked up by the enameling robot itself as necessary. The interchangeable containers can be coupled at different stations to any one of the numerous lines. In a different embodiment, only two containers are provided, of which one container respectively is mounted to the robot while the other is being filled at a color changer annexed to connecting lines. A system of this type avoids long tubes between the spraying arrangement and the supply lines and permits electrostatic coating with electrically conductive coating material without the problem of a conductive connection between the spraying arrangement and the supply lines.

However, this system requires a relatively high control cost if each paint supply line is associated with its own interchangeable container, because the robot must run to a different dispensing station for each color change. In addition, when the robot runs to the dispensing station, it must wait for the container to be filled. On the other hand, if only two containers are available for alternate filling and use, they must be rinsed for every color change, which leads to a loss of time in the coating operation as well as a loss of the remaining material in the container on a reserve basis. In each case, the robot must execute laborious control movements in order to couple the containers to the dispensing stations.

In order to supply paint to an enameling robot for vehicle bodies, which has containers that can be mounted to the robot arm in an interchangeable manner, it is also conventionally known to transport containers filled with the quantity required for each body successively on a conveying belt to a discharge point, from which they are removed by an auxiliary robot and delivered to the enameling robot.

SUMMARY OF THE INVENTION

The present invention provides a paint system for production line coating of workpieces, particularly vehicle bodies, having the greatest possible flexibility with respect to the paints, spraying arrangements and coating machines used. The paint system includes a paint supply system which, when filling the interchangeable containers, limits the loss due to color change and provides a coating operation which is significantly free of delay. The paint supply system also preferably manages to limit control effort for the control of required movements.

The paint system further includes a paint spray system including a coating machine whose exchangeable container can be coupled to the valve unit of the spraying device simply and with low control effort and which does not impair the dynamic motion behavior of the machine.

For the paint supply system of the present invention, the containers can each be refilled with material of the same color. The containers are rinsed only if a control and monitoring system establishes that the containers were not used for coating for a preset amount of time, or were not emptied completely during coating, or were not refilled after being emptied or in an exceptional case, if a container must be filled with a different color. Consequently, the loss f paint due to regular rinsing is avoided.

Since color loss by means of rinsing only rarely occurs, the respective filling quantities also are not critical in this respect. It can be advantageous to fill the containers only with a predetermined quantity of material that is required for a predetermined coating process, e.g., in order to coat one body; it is normal, however, to require a sufficient reserve quantity. However, excess paint can remain in the container and be sprayed during the next use of the container.

Since all containers can be refilled and, if necessary, rinsed during normal coating operation without interruption, the system also operates with the least possible loss of time. Loss of time can be limited to the time required to couple and decouple the containers to and from the paint spray system with an advantageous prior positioning of the containers of the transport assembly. For coating, this loss of time can also be avoided if at least two paint spray systems that alternate operation are provided.

The present paint system is suitable for supplying paint to any coating system, e.g., to electrostatic systems for conventional enamel or electrically conductive water-based enamel, or to air atomizers; in fact, not only to robots such as the aforementioned known systems, but to any coating machines. In this regard, only simple movements must be controlled, which in turn can reduce the control effort considerably for robots and other multiaxis coating machines. For movements which are simple to control, containers inserted in the transport assembly are removed at the discharge point by means of a linear movement assembly that moves the containers along a straight path between the coating assembly and the transport arrangement. In the case of a multiaxis enameling machine, the arm that carries the spraying assembly can be pivoted, on the side of

the machine facing the transport assembly, from or back to the transport assembly in order to take over the containers, said transport assembly likewise being simple to control. The same advantage ensues if the coating machine is conducted, parallel to the transport direction of the workpieces to the coated, to the discharge point, in order to take over and deliver the containers. A container is preferably inserted through an opening of the arm into its interior space, where it can be coupled very easily, on one end, to control valves of the rinsing arrangement, and, on the other end, to an electromechanical drive for a metered emptying of the container.

Since the interchangeable containers can be filled relative slowly without causing delays for the coating operation due to their intermediate storage on the transport arrangement, there is no need for high pressure in the lines, which protects the coating material flowing in the lines, which as a rule is pressure-sensitive. For the same reason, pressure fluctuations in the lines are far less critical than for systems depending on the quickest possible filling.

In addition, the invention enables a trouble-free coating with practically any color shade, since not only are the colors delivered in previously conventional supply lines available, but furthermore, all possible mixtures of these and/or additional colors are available. Mixing can be carried out in the container by filling it with different colors, or even prior to filling the container in question, and in fact, can be carried out automatically or manually by guiding together at least two different colors, e.g., from the annexed supply lines. As a rule, any optional preparation of colors, which can be selected with flexibility, is carried out fully automatically; it is executed by means of an electronic control system, according to the respective demands. In special cases, the transport assembly can also be

equipped with containers filled externally, without being annexed to the supply lines of the filling station of the system described here.

At the filling station, a device shall be provided which automatically couples a container to a device fed by at least one supply line. The arrangement of colors on the transport assembly can be carried out at any optional positions according to usefulness, since the automatic devices provided at the discharge point and at the filling station, in order to supply and remove or to fill the containers have free access to all positions on the transport assembly.

The filling station or at least the discharge point could be located within the spray booth in which coating conventionally is carried out. However, a spray booth preferably contains as few components of the overall system as possible, especially in the actual spraying region due to the danger of dirt accumulation by means of the sprayed coating material and due to the impairment of the freedom of movement of the coating machines. For the system described here, it is therefore preferable to locate the transport assembly completely outside of the spray booth. For example, the transport assembly in preferably located in the maintenance region of the system and is separated from the paint spray system by means of a wall, with containers being supplied to the paint spray system and returned to the transport assembly through an opening in the wall. Since the filling station is also located outside the booth, the closed circular supply lines, in which coating material circulates, do not need to be guided as far as into the booth. The lines can therefore be shorter and narrower.

Th spray arm of the spray machine is brought for exchanging the container into a position in which a manipulator device, performing a linear movement

perpendicular to the arm opening, can insert and remove the container. When inserting the container with this manipulator device, it can be connected very simply to the valve unit of the spraying device, likewise provided in the interior of the arm, and separated from it during removal. All supply and control lines leading to the spraying device can run in the interior of the movable elements of the machine.

In operation, the container need only participate in the arm motions of the machine, but not in the additional axial movements of the spraying device. The container in the arm interior is also easily insulated when it is subjected to high voltage in an electrostatic coating operation with conductive material. Preferably, the arm of the machine consists of insulating material over a length sufficient for insulating the spraying device and the container from grounded parts of the machine.

An additional advantage of the invention consists in the fact that a container constructed as a metering cylinder with a movable piston can be easily coupled in the interior of the arm to an electromechanical control drive for metered emptying of the container. In particular, when removing the container from the machine, a piston rod which remains in the machine and which can be coupled to the inserted container can be driven by an electric servomotor installed in the machine of a type corresponding to the motors provided in the machine for axial driving.

BRIEF DESCRIPTION OF THE DRAWINGS

The above, as well as other advantages of the present invention, will become readily apparent to those skilled in the art from the following detailed description of a preferred embodiment when considered in the light of the accompanying drawings in which:

Figure 1 is a basic representation of the paint system of the present invention;

Figure 2 is a schematic representation of an arrangement with which a container can be moved between the paint spray system and the transport assembly in accordance with Figure 1;

Figure 3 is a schematic representation of a filling station of the system in accordance with Figure 1;

Figure 4 shows a simplified longitudinal section through the arm of the painting robot of Figure 1;

Figure 5 shows a schematic representation of the system for connecting the exchangeable container to the spraying device of Figure 1;

Figure 6 is an alternate embodiment of the paint supply system of Figure 1; and

Figure 7 is a schematic of another alternate paint supply system which can be used in the paint system of Figure 1.

DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT

The paint system 20 of the present invention is generally shown in Figure 1 comprising a paint supply system 22 for supplying paint to a paint spray system 24.

The transport assembly itself of the system described here can be of any optional type, e.g., a belt conveyor or a chain conveyor. The paint supply system 22 comprises a magazine 26, which can rotate in either direction. The magazine 26 is provided with devices to accept and hold cartridge-like containers 28 at a multitude of uniformly distributed positions, as is known and conventional for tool magazines in connection with tool-changing arrangements. Preferably, the magazine

26 stores a multitude of containers simultaneously, at least equal to r preferably double the number of colors which can be selected.

Arrow 32 indicates a filling station 32 in which the containers 28 inserted in the magazine 26 are automatically filled with the different colors desired in each case. Preferably, the containers 28 remain in the magazine 26 during filling, if a movable filling device 34 is coupled to the container to be filled. Alternatively, the containers can be removed from the magazine 26 by means of a suitable arrangement and then likewise automatically coupled to the filling device 34 for filling. The filling device 34, contains a color changer 36 or at least a movable device connected to a color changer, with the color changer 36 being annexed to a multitude of closed circular pipelines designated, in general, as 38, in which circulate different colors of available coating materials. Individual containers, e.g., with individually mixed special colors, can be inserted manually at the manual filling station 40.

At the discharge point indicated by arrow 42, a filled container 28a is seized, removed from the magazine 26, and supplied along the represented straight path 48 to the paint supply system 24 by means of a linear movement assembly 46 which, e.g., has a piston-cylinder driving unit and can be mounted on the magazine 26.

The paint spray system 24 comprises an enameling robot 50, which can be moved, as shown by arrow 52, parallel to the transport direction of workpieces (not represented) supplied with a conventional conveyor. The robot 50 is moved back and forth in this direction between a working position 50a and a container-changing position 50b, in which a filled container is delivered to the former and an empty

container is removed. Th container 28a shall preferably be inserted through an opening 54 in the housing 56 of the arm 58 of the robot 50 and there be coupled to a control valve construction of the spraying arrangement. For this purpose, the robot arm 58 is pivoted more than 90 degrees, preferably more than 180 degrees, and most preferably approximately 270 degrees in the vertical position represented, in which the aforementioned opening of the arm 58 is facing the delivery arrangement 46 of the magazine 26, hence, is located in a vertical plane which intersects the horizontal path 48 roughly at a right angle. The pivoted movement of the robot arm 58 required for this is made possible by the single-sided support of this arm 58 on the robot 50 as represented. Hence, the robot 50 need only execute a few simple movements to reach the container-changing position 50b and to receive a filled container and deliver an empty container. The arm 58 is positioned on one side of the paint spray system 24 for spraying paint and on the opposite side of the paint spray system 24 for receiving containers 28.

While the robot 50 is located in the container-changing position 50b, before insertion of a full container 28a, the container 28b used before and now empty, represented by a dashed line in the figure, first is removed from the robot arm 58. For this purpose, the linear movement assembly 46, only represented schematically, can be as shown in Figure 2, such that it can hold at least two containers 28 simultaneously, hold the full container 28a ready while it removes the empty container 28b. In this regard, Figure 2 schematically represents that the linear movement assembly 46 also carries out a transverse movement perpendicular to the horizontal path 48; this can also be a rotational movement. After the new container 28a has been inserted, the robot 50 travels back to its working position 50a.

For th example described, the linear m vement assembly 46, which removes the container 28 from the paint supply system 22 and supplies it to the paint spray system, also returns the container 28 to the paint supply system 22. The possibility also exists of providing two movement assemblies 46 at the discharge point 42, of which one supplies containers 28 to the paint spray system 24 while the other movement assembly 46 returns a different container 28 to the paint supply system 22.

The robot 50 operates conventionally within a spray booth. Based on, among other reasons, the aforementioned linear movement of the containers 28 along the path 48, the very advantageous possibility exists of arranging the paint supply system 22 including the magazine 26, fully outside of the booth, and of separating it from the robot by means of a wall (not represented). The containers 28 can be supplied to the paint spray system 24 without trouble and returned to the magazine 26 through an opening in this wall.

Of course, in production line coating of workpieces, such as motor vehicle bodies, additional enameling machines can be located within the booth; in particular, a second enameling robot can operate on the opposite side of the body to be coated, and can obtain its interchangeable containers from an additional supply system, of the type described, provided there. It is also possible to provide at least two magazines or transport arrangements of the type described, operating in parallel, on the same side of the booth.

In addition, the possibility exists of using one supply system of the type described here in order to supply two robots r other coating machines, of which one machine respectively works while the paint containers are changed for the other

respective machine, such that a changing of the containers need not interrupt the coating operation.

A manual manipulation assembly could be used to fill the containers 28; it is preferable, however, for the containers 28 to remain in the magazine 26 during filling, in accordance with Figure 1. A control valve, which is both connected to the color changer 36 and is movable, is coupled, e.g., from below, to the valve openings provided in an end wall of the container 28, as represented with greater precision in Figure 3.

In accordance with Figure 3, the cartridges or containers 28 are in the form of cylindrical metering containers that contain a piston 60, which can be displaced within the container. The position of the piston 60 in the container defines the volume to be filled and hence, the amount of enamel to be sprayed. The position of the piston 60 can be set by means of a piston rod 66 prior to filling by an electric motor 64, preferably a stepping motor, which is controlled by means of the electric control system of the filling station according to the respective quantity of enamel required.

While the piston 60 is operated from one end of the container 28, the container valves 70, 72 provided for filling and emptying are located at the opposite end. The valve 70 serves for filling at the filling station and in order for coating material to be removed during coating. The valve 72 serves, if necessary, to empty the container 28 in the filling station in which the container can also be rinsed. A handle 62 for the aforementioned manual manipulation assembly, for inserting the container in the robot and for returning it to the magazine 26 can be attached to a

side wall of the container 28. Centering means f r aligning the valves 70, 72 with those of the color changer are located at the ends of the container 28.

The color changer 36 with a control valve unit 74 connected to it is coupled to the container 28. In this regard, a line 78 connects the container valve 70, to the color changer 6, by means of corresponding valves F1-Fn, to a number of closed circular pipelines or other supply lines for different colors. Likewise in a conventional manner, the color changer also contains valves V for a rinsing agent or solvent and additional valves PL for compressed air used to empty and rinse the container 28. Return valves, designated RF, are connected to a line 84 which, connects a drain valve 72 of the container 28 to a collecting receiver 84. When necessary, rinsing liquid travels through the line 78 and valve 70 into the container 28. The control valve unit 74 is automatically rinsed when the container is decoupled.

It is preferable to provide the containers 28 with readable mechanical identifier data 90 such as barcodes or magnetically stored data, with respect to color shade, quantity of paint, container number, container size, identification of the coating process to be carried out, etc., such that an optimum monitoring and control of the operation is always possible. In particular, the electronic control system can assign the container to a certain workpiece to be coated. The identifier data on the container can either be permanent or have the ability of being overwritten.

Figure 4 shows the arm 58 of a painting robot. It consists essentially of an elongated housing 56 that is seated at its right end in such a manner as to be movabl (not shown), and at its opposite end supports additional movable elements including a wrist or hand axis construction 100, on which the spraying device is

arranged. The required lines run through the interior of the hand axis construction 100 from the spraying device (not shown in Figure 4) to a valve block 102 installed permanently at the end of arm 58 in its housing 56.

The housing 56 of the arm 58 is closed off towards the outside with the exception of the opening 54 located on one side of the arm and dimensioned sufficiently long and wide that the cylindrical container 28 can be inserted through the opening 54 into an interior space of the housing 56 to the illustrated position, in which its own axis lies parallel to that of arm 58, and removed after use. In its end face turned toward the valve block 102, the container 28 has the outlet valve opening 106 which lies flush during the emptying process with an inlet opening of the valve block 102 facing toward the end face of the container. The precise alignment is achieved by centering means 108 that are provided on the valve block and on the end of the container and come into engagement during the axial pressing-together and coupling of the container 28 to the valve block 102. For pressing the container against the valve block 102 and locking it there, a pneumatic locking cylinder 138 is provided.

As stated above, the container 28 is constructed as a metering cylinder. It contains a piston 60 movable in the container in order to empty it. As described above, the piston which can be moved during or before the filling of the container at the remote filling site into a position in which it defines a preset filling volume for the coating material filled through one of the valve openings 70. In the example shown, this is the entire container volume, but in other cases, a volume can be set which is just sufficient for a predefined coating process plus a necessary reserve.

In case of complete emptying, th metering piston 60 contacts th interior wall of the end face of the container 28, as shown at 60a

For the metered emptying of the container 28, a piston rod 116 seated so as to be axially movable along the housing 56 acts on the metering piston 60 through an opening 114 provided in the rear container end; said rod 116 is not continuously in contact with the piston 60, but remains instead in the housing 56 during the exchange of the container. The piston rod 116 is driven, via a clutch 124, a belt of gear transmission 126, a spindle nut 130 guided at 128 and a spindle 134 seated at 132, by an electric servomotor 122 housed in an enlarged part 118 of the housing. An absolute value sensor for the servomotor 122 and an inductive rpm gauge 136 provide precise control of the metered emptying of the container 28. The housing part 118 is closed at its rear end by a lid 120.

At its end facing the container 28, the piston rod 116 is seated in the pneumatic stop cylinder 138 serving to stop the container. A pneumatic contact sensor 142 that generates a pneumatic signal when the piston rod 116 strikes against the metering piston 60 is seated in the end face of the piston rod 116.

The coating machine described here can work in principle with any arbitrary spraying device. If, however, an electrostatic spraying device is used for spraying electroconductive coating material, the valve block 102 and the container 28, which are constructed of pressure-resistant metal, are raised to a high voltage. Therefore, it is necessary to assure electrical isolation from the normally grounded metal parts of the machine. For instance, the expanding housing part 118 preferably consists f aluminum. The housing 56 f the illustrated robot arm 58 preferably consists of a mechanically-stable plastic or other insulating material from the valve block 102

up to the housing part 118. Th length f the insulating housing 56 is dimensioned such that the required isolating path 144 is created between the rear end of the stop cylinder 138, which is metal and the metal housing part 118. The piston rod 116 likewise consists of insulating material.

Figure 5 schematically illustrates the supply system of an electrostatic spraying device 148, which can, for instance, be a conventional rotary atomizer and is intended to spray the coating material from the container 28 installed in the robot arm according to Figure 4. If the container 28 is inserted and coupled to the system, the main needle valve of the spraying device 148 is connected via a line HN and a paint valve F in the control valve block 102 to the inlet opening 150 of the valve block, and consequently the valve opening 70 of the container 28.

Furthermore, a rinsing agent line V leads into the valve block 102. A line KS leads from the valve block 102, and serves for brief rinsing of the atomizer bell while circumventing the main needle line HN and is branched off into the spraying device 148. The rinsing agent consisting of thinner in the line V reaches the line HN and the spraying device as needed, particularly when changing paint. Through an additional line PL, compressed air reaches the valve block 102 and the spraying device 148 via line HN. Finally, a line RF, likewise connected to the valve block 102 and in parallel thereto to the spraying device 148. Unsprayed coating material and rinsing agent are directed from the other lines, the control valve block and the spraying device through the line RF into a collecting container S, particularly during a change of paint. The described lines are located on the inside of the movable machin elements.

If conductive paints are sprayed in the vicinity of the spraying device 148 and the valve block 102, the lines can be at a high potential and are therefore constructed in their continuations to be insulating. The necessity of electrical insulation is absent if, for instance, a pneumatic atomizer 148a, rather than an electrostatic spraying device, is connected to the control valve block and the line RF.

In operation, the container 28 is filled at a point removed from the paint spray system 24 and preferably conveyed outside the conventional spraying booth by the paint supply system 22 as described above to a container exchange point, where it is gripped by a manipulator device and is inserted through an opening of the booth wall along a linear conveyance path into the opening 114 of the housing 56 of the arm 58 shown in Figure 4. The container 28 is equipped, on one side for instance, with a handle 152 (Figure 4) by which it is seized by a gripper 154 of the aforementioned manipulator device. The process of pressing against and coupling to the container 28 occurs automatically. After use, the container is again removed from the arm 58 by the manipulator device, which simultaneously inserts a new container filled as needed with the same or a different paint, unless it is more practical to use separate devices for insertion and removal.

Figure 6 represents a different embodiment of the paint supply system. Here, a belt or chain conveyor 156 serves as the transport arrangement, in which the containers 28 are held in a horizontal position by means of a chain or belt 158, and which revolves about a horizontal axis.

As with the embodiment in accordance with Figures 1 and 3, a color changer 160 is connected by lines 162 to cl sed circular pipelines or, preferably, a movable

filling coupler 170 with the ability to be rinsed. The movable filling coupler 170 is fed by the color changer 160, is coupled to a container 28 to be filled by means of an automatically controlled shifting device. In addition, additional supply lines 164 are connected to the color changer 160, and at least some lines lead to pressure chambers 166 or to other supply tanks for special colors or other coating materials that cannot be drawn from the lines 162. For example, different colors could be mixed in the chambers 166. In each case, the lines 162, 164 include control air lines for valve actuation.

As with the embodiment in accordance with Figure 1, a linear movement arrangement 168, e.g., one driven by means of a piston-cylinder unit, or a different positioning device, is provided in order to remove and reinsert the containers 94. In each case, the conveyor 90 is positioned by means of a drive 172 controlled by the electronic control system such that the containers required in each case are removed and refilled at the correct point in time at the discharge point and filling station.

Preferably a flow meter 176 is positioned on the line which leads from the color changer 160 into the containers 28. This can be used to monitor a metered filling or, by means of a corresponding control of the present valves, to control the filling quantity. Hence, the piston control described with the embodiment in accordance with Figure 3 is not required.

With the use of electrostatic spraying arrangements, the spatial clearance of the filling station from the discharge point or from the spraying arrangement is at least as great as the clearance required for an electrical insulation. Independent of

the type of spraying arrangement, however, a filling station shall be located outside the spray booth for the reasons already cited above.

Figure 7 schematically indicates a paint supply system according to another embodiment example of the invention. In this example, a standard side machine 198 used in automobile painting technology can be supplied with different color coating material as coating device 200, according to the illustration. The coating device 200 is located at the transfer point 42, to which the filled containers 28a are transported from the filling site 32 to moving magazines 204. The conveyance of these magazines 204 used as moving transport devices, from the filling site 32 to the transfer site 42, can take place by different means or conveyors 208, as necessary; for example, with a rail-based conveyor or conveyor linked by an induction coil, or a chain conveyor, etc., or in special cases, even manually, onto the illustrated cart.

One alternative possibility (not illustrated) consists in moving the container 28 or a suitable magazine by means of a pneumatic tube system in a known manner.

When using a number of coating devices, the containers 28, or in the illustrated example, their magazines 204, can be supplied either directly from the filling site 32 from the individual coating devices, or instead, the magazines can move the various coating devices one after the other, where one filled container is removed and/or an empty container can be returned from the coating device into the magazine.

There are several possibilities for filling the container 28 at the filling site 32; for example, connecting empty containers to ring lines or other lines, or to large supply vessels. It is also possible to set up filled containers supplied from outside

of the particular system, in the filling station for transport to the transfer site 42. According to one particular characteristic of the invention, a mixing bench 210 can be provided at the filling site, from which various coating substances of differing colors are moved into the container, which are mixed in advance, or are mixed in the containers, into the desired color tone. Furthermore, the containers can be rinsed at the filling site. It is also possible to regenerate the coating material from not completely emptied containers 28. The containers can be subjected to a quantity check and a pressure test; they can be shaken to agitate their content, and they can be positioned automatically with respect to the magazine 204 and with respect to the existing filling devices.

Both the filling and possible emptying and rinsing of the containers at the filling site 32, and also the loading of the conveyer 208 (represented as a cart) can take place manually or automatically.

As described above, the containers 28 can be provided with machine-readable or visually readable identification data to identify their contents, including paint type, filling date, etc. If several magazines 204 are used, they are also provided with separate identifiers or characteristic data to identify the containers held therein.

According to the illustration, the magazine 204 can be removed with the containers 28 to be filled, from a reserve magazine supply 212, and moved from there, e.g., by means of an automatic handling unit 216 or another conveyance device, or even manually, to the positions necessary for filling, emptying or rinsing. The reserve magazine supply 212 can be located directly at the filling site 32, in a paint mixing room or at a remote site. The reserve magazine supply 212 can

contain magazines 204 and/or single containers 28. They can be completely or partially full, empty, used, or rinsed.

A reserve magazine supply with already filled containers could also be provided. Furthermore, it is possible to heat the reservoir so that the coating material is first brought to an optimum temperature. In this case the containers are preferably provided with thermal insulation during their transport to the coating device 200.

The containers 28 removed from the coating device at the transfer site 42 after use can be transported first into the reserve magazine supply 212, as illustrated, before they are reused at the filling site 32. The magazine 204 used for transport into the reserve magazine supply 212 can be transported on similar conveyors 208, as on the path to the coating device 200.

The entire operating sequence is monitored and controlled, preferably by an aligning and control system 218. This system ensures, in particular by using the mentioned characteristic data, that all existing coating devices are supplied as quickly as possible and with the smallest possible material losses, with the coating material needed in the particular case.

The containers used according to this invention have numerous, inherently advantageous properties. They are suitable for metering, airtight and designed as pressure vessels. They provide protection against aging of the coating material and act as transport containers, paint reservoirs and for decoupling of the coating devices from ring lines or other paint supply systems. They are portable, rinsable and reusable and they can be identified in a simple manner. Furthermore, they are easy to grasp and can be easily centered and locked into position.

WHAT IS CLAIMED IS:

1. A method for supplying paint to a coating device comprising the steps of:

a) seizing a first container from a plurality of containers of paint on a transport assembly;

b) installing said first container into a paint spray system;

c) spraying said paint from said first container onto a workpiece;

d) removing said first container from said paint spray system;

e) returning said first container to said transport assembly;

f) filling said first container with paint while said first container is in said transport assembly;

g) seizing a second container from said plurality of containers; and

h) installing said second container into said paint spray system.

2. The method according to Claim 1 further including the steps of:

moving a color changer to a position adjacent said first container on said transport assembly, said color changer including a plurality of valves each connected to a supply line of different colors of paint;

connecting said color changer to said first container during said step f); and

filling said first container with paint through one of said plurality of valves from said color changer.

3. The method according to Claim 1 wherein said step g) is performed before said step d), and said step h) is performed before said step e).

4. The method according to Claim 1 wherein said container includes an axially moveable piston within said container, said step c) further including the steps of:

moving said piston axially; and

measuring the movement of said piston to measure the volume of paint sprayed.

5. The method according to Claim 1 wherein said paint spray system includes a paint sprayer mounted on an outer end of a moveable spray arm, said spray arm including a housing having an opening, said steps b) and h) each including the step of inserting said container through said opening into said housing.

6. The method according to Claim 5 wherein said spray arm is moveable rotatably about a generally horizontal axis, said step c) performed while said spray arm is operating on a first side of said paint spray system, said steps b) and h) performed while said spray arm is rotated about said generally horizontal axis to an opposite side of said paint spray system.

7. The method according to Claim 1 wherein said step c) further includes the step of removing said paint from said first container through a first valve in said first container, said step f) further including the step of filling said first container through said first valve.

8. The method according to Claim 7 further including the step of aligning said first valve of said first container with a valve block disposed in said paint spray system.

9. The method according to Claim 8 wherein said step f) further includes the steps of:

rinsing said first container with a rinsing agent introduced into said first container through one of said first valve or a second valve in said first container; and

simultaneously removing any remaining amount of said paint from said first container through the other of said first valve and said second valve.

10. The method according to Claim 1 wherein said transport assembly is a rotatable magazine rotating generally about a vertical axis, said containers disposed circumferentially about said vertical axis.

11. The method according to Claim 1 wherein said transport assembly is a conveyor rotating generally about a generally horizontal axis, said containers disposed circumferentially about said horizontal axis.

12. The method according to Claim 1 wherein said steps a) and d) each include the step of seizing a handle formed on said first container.

13. The method according to Claim 1 wherein a plurality of containers including said first container are disposed within a magazine, said step b) including the step of installing said magazine into said paint spray system.

14. A coating machine comprising:

a moveable arm having an axial inner end and an opposite axial outer end;

a spray device mounted on said outer end of said arm;

a piston rod disposed in said arm;

a meter operably connected to said piston rod, said meter indicating relative position of said piston rod; and

a removable container removably mounted on said arm, said container including an axially moveable piston moveable from an axial inner end of said piston to an axial outer end of said piston, said piston rod engaging said piston, said meter indicating the relative position of said piston rod, said spray device determining the volume flow of paint through said spray device based upon a change in said relative position of said piston rod.

15. The coating machine of Claim 14 wherein said arm further includes a housing having an axial outer end and opposite inner end, said housing having an opening located between said outer end and said inner end, said container insertable and removable through said opening in said housing.

16. The coating machine of Claim 14 wherein said arm further includes a valve block, said spray device in fluid communication with said valve block, said container further including a valve in commication with said valve block, paint being supplied to said spray device through said valve and said valve block.

17. A coating machine comprising:

a moveable arm including a housing having an axial outer end and opposite inner end, said housing having an opening located between said outer end and said inner end;

a spray device mounted on said outer end of said arm; and

a container selectively insertable and removable through said opening in said housing.

18. The coating machine of Claim 17 wherein said arm is moveable rotatably about a generally horizontal axis, said container supplying paint to said spray device while said arm is in a first rotation position about said horizontal axis, said arm being rotated more than 90 degrees about said generally horizontal axis from said first rotation position to a second rotation position, said container being removed and inserted into said arm while said arm is in said second rotation position.

19. The coating machine of Claim 17 wherein said arm further includes a piston rod disposed in said arm, a meter operably connected to said piston rod, said meter indicating relative position of said piston rod, said container including an axially moveable piston moveable from an axial inner end of said piston to an axial outer end of said piston, said piston rod engaging said piston in said arm, said meter indicating the relative position of said piston rod, said spray device determining the volume flow of paint through said spray device based upon a change in said relative position of said piston rod.

20. The coating machine of Claim 17 wherein said arm further includes a valve block, said spray device in fluid communication with said valve block, said container further including a valve in commication with said valve block, paint being supplied to said spray device through said valve and said valve block.

21. A paint system comprising:

a transport assembly removably receiving a plurality of paint containers;

a paint spray system including a moveable arm having a spray device mounted on an axial outer end of said arm, said spray device receiving paint from a first container of said plurality of paint containers;

a moveable paint filling device including a plurality of valves each connected to a supply line each supplying a different color paint, said filling device filling said plurality of paint containers with said different color paints while said containers are located in said transport assembly;

a movement assembly seizing said first container from said arm of said paint spray system after said spray device receives said paint from said first container, said movement assembly returning said first container to said transport assembly and seizing a second container from said plurality of containers, said movement assembly inserting said second container into said arm of said paint spray system, said paint filling device filling said first container with paint while said container is located in said transport assembly.

22. The paint system of Claim 21 wherein said moveable arm includes a housing having an axial outer end and opposite inner end, said housing having an opening located between said outer end and said inner end, said containers being insertable and removable into said arm through said opening.

23. The paint system of Claim 21 wherein said arm is moveable rotatably about a generally horizontal axis, said container supplying paint to said spray device while said arm is in a first rotation position about said horizontal axis, said arm being rotated more than 90 degrees about said generally horizontal axis from said first rotation position to a second rotation position, said container being removed and inserted into said arm while said arm is in said second rotation position.

24. The paint system of Claim 21 wherein said arm further includes a piston rod disposed in said arm, a meter operably connected to said piston rod, said meter indicating relative position of said piston rod, said container including an axially moveable piston moveable from an axial inner end of said piston to an axial outer end of said piston, said piston rod engaging said piston in said arm, said meter indicating the relative position of said piston rod, said spray device determining the volume flow of paint through said spray device based upon a change in said relative position of said piston rod.

25. The paint system of Claim 21 wherein said arm further includes a valve block, said spray device in fluid communication with said valve block, said container further including a valve in commication with said valve block, paint being supplied to said spray device through said valve and said valve block.

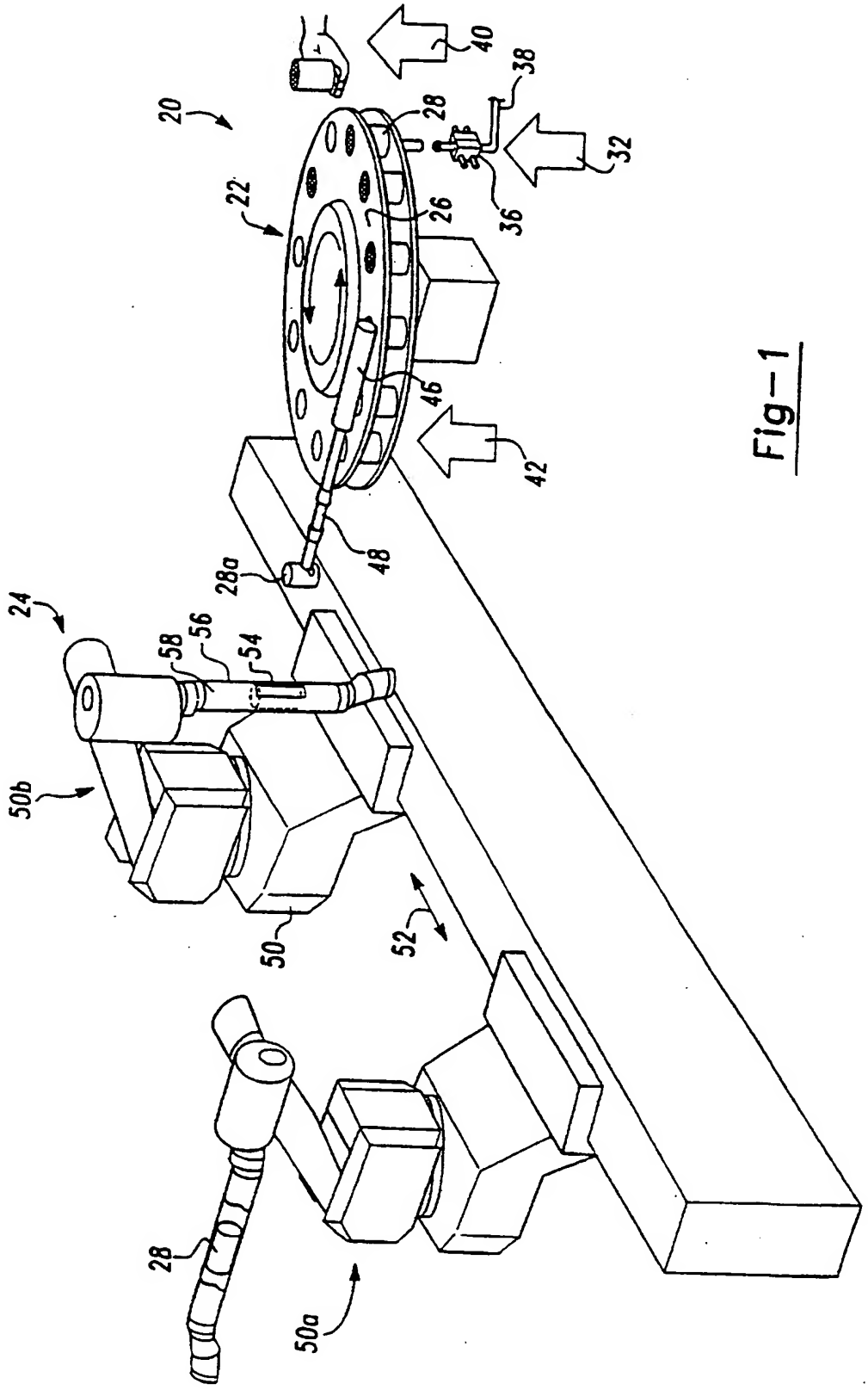

Fig-1

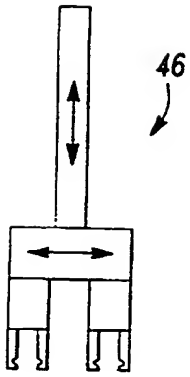
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Fig-2

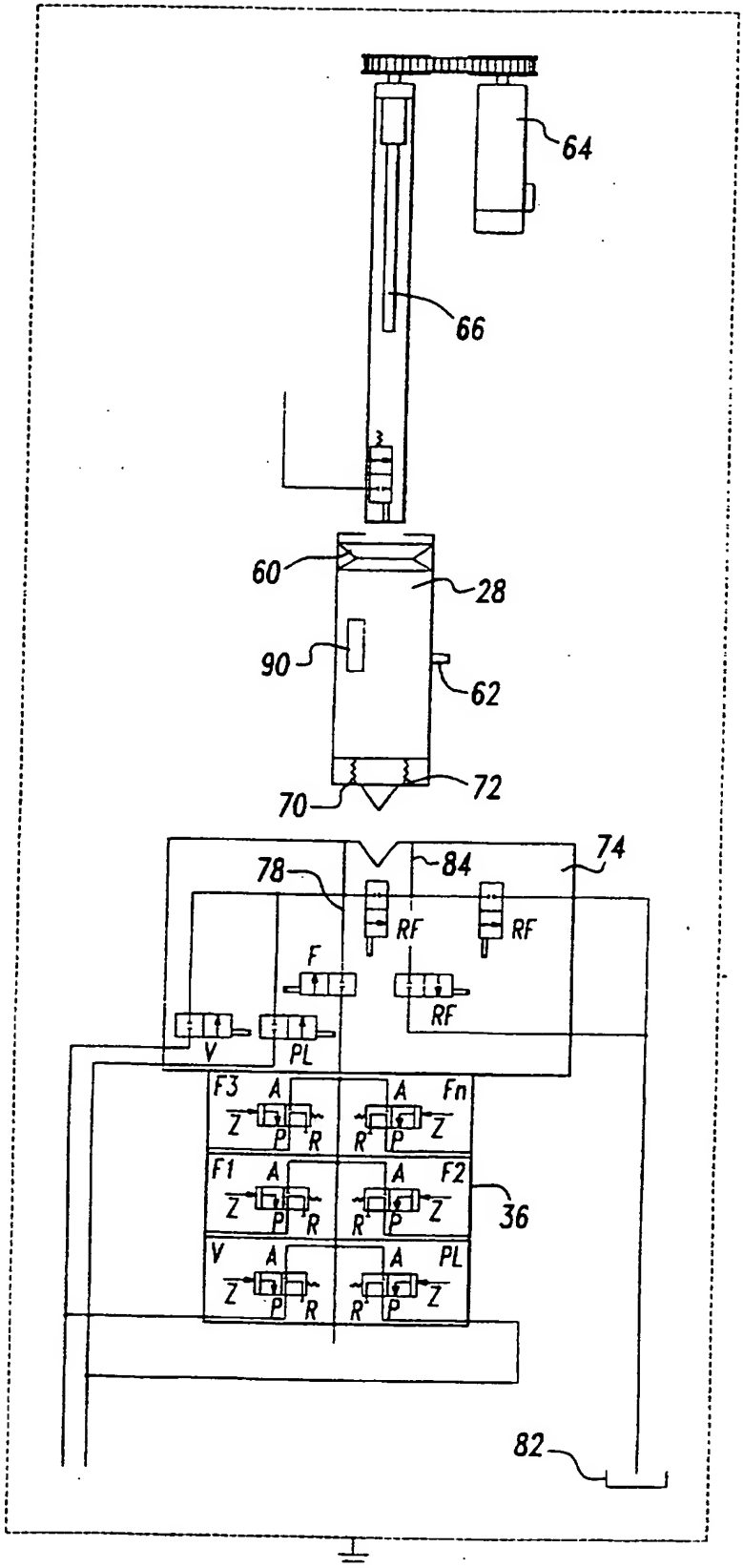
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Fig-3

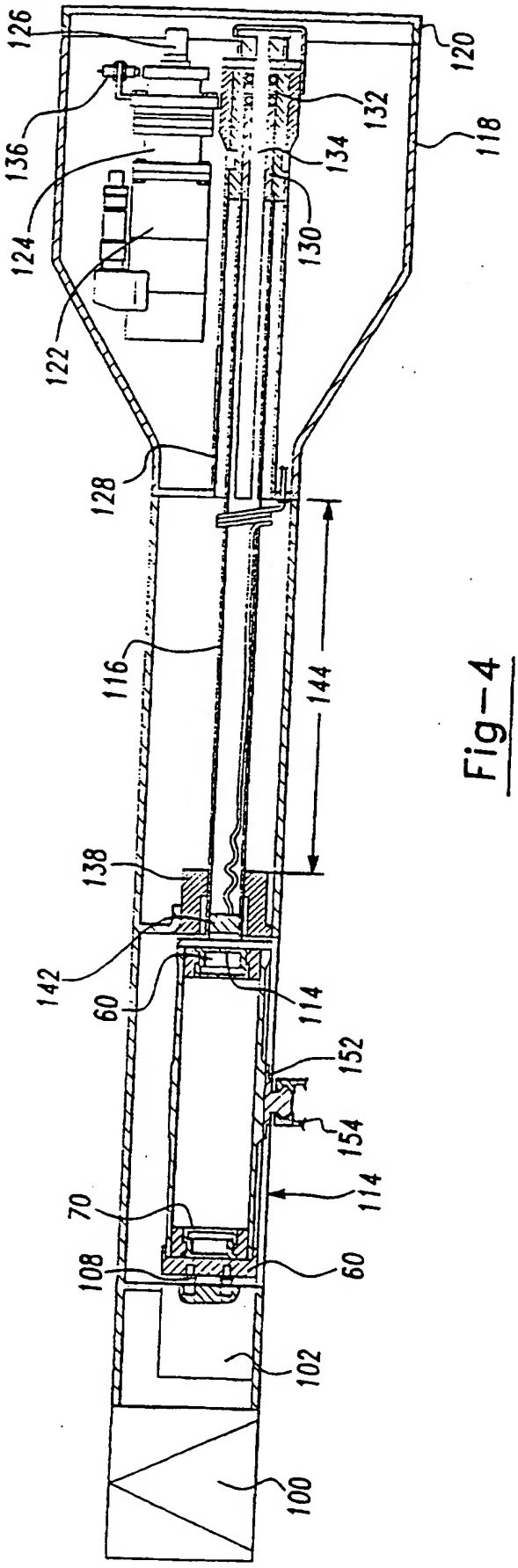
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Fig-4

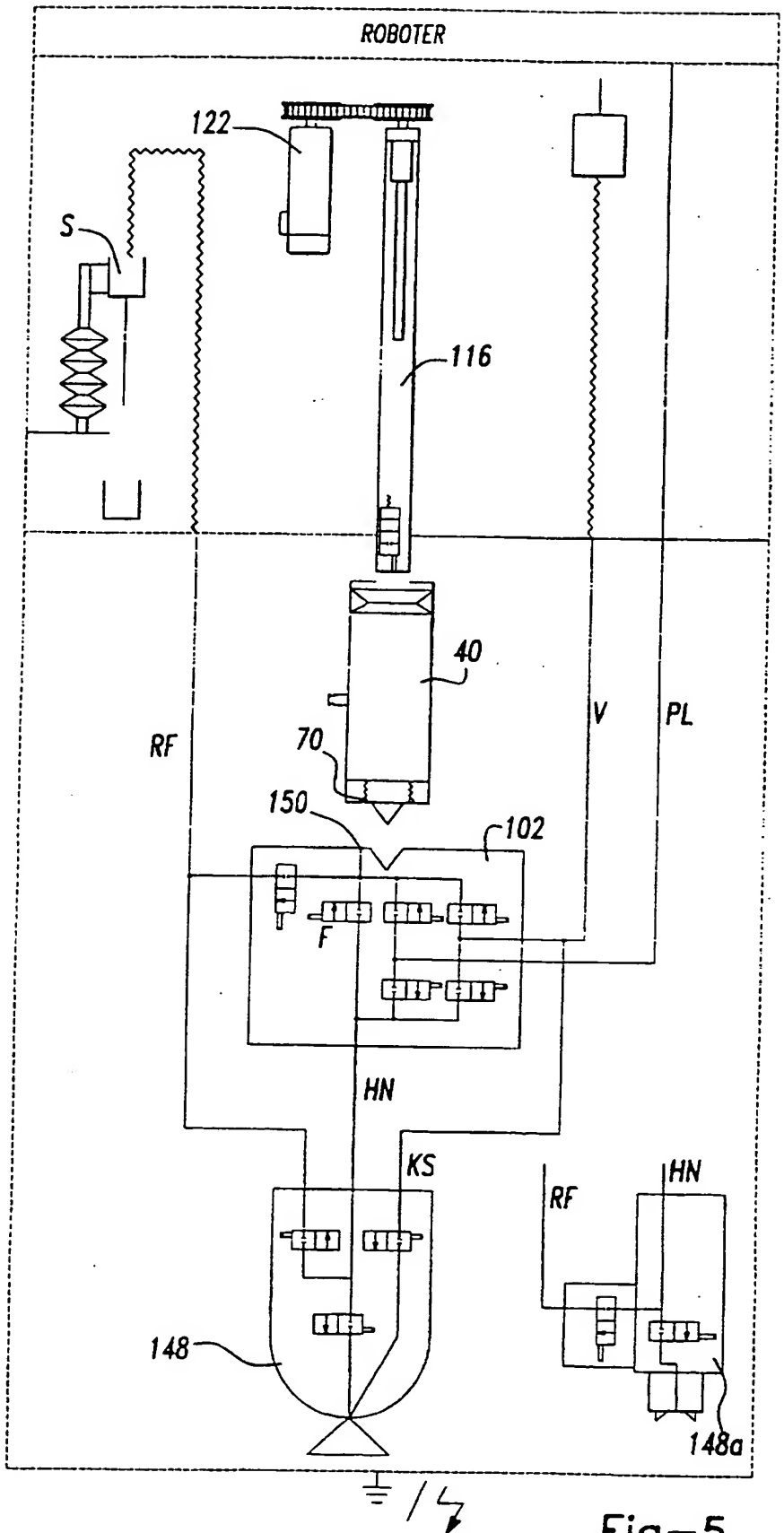

Fig-5

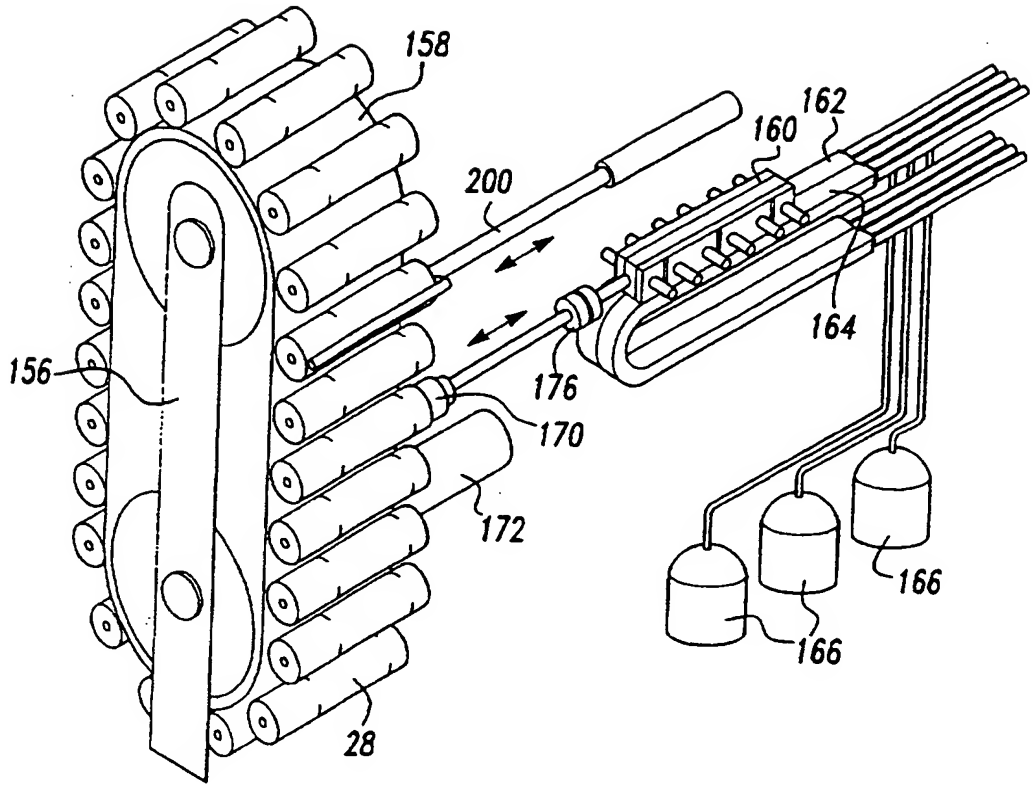

Fig-6

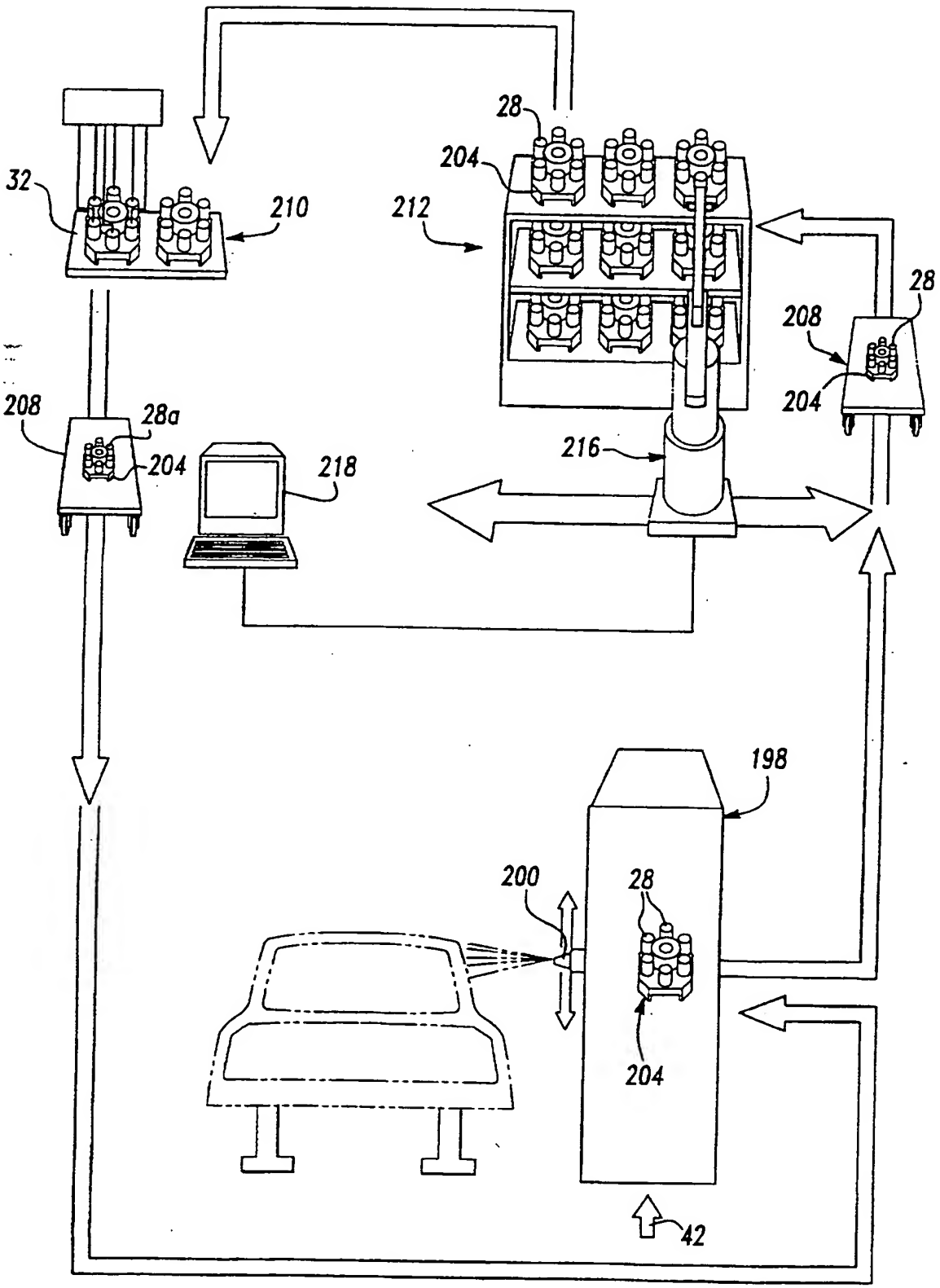

Fig-7

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US97/04209

A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) :B05D 1/02; B05B 3/00
US CL :427/421; 118/323
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 427/421; 118/323

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

none

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

APS - search terms: paint, spray, containers

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 5,230,739 A (BARTOW et al) 27, July 1993, column 3 lines 3-64	1-25
Y	US 5,415,352 A (MAY) 16 May 1995, column 3 lines 36-58	14-25
Y	US 4,798,341 A (GIMPLE) 17 January 1989, column 2 lines 17-68	1-13
A	US 5,217,238 A (CYPHERS et al) 08 June 1993, column 1 lines 45-60	1-25
A	US 5,236,504 A (FRIKKER) 17 August 1993, column 2 lines 6-53	1-25

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
07 JULY 1997	14 AUG 1997
Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. (703) 305-3230	Authorized officer BRET CHEN Telephone No. (703) 308-0661

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